Appendix I
Survivability and Vulnerability Issue: System Evaluation Considerations

I–1. Overview of the survivability evaluation process

The survivability T&E process is part of the continuous evaluation (CE) process. As part of that process, the evaluation must address design or configuration changes that could affect the system's survivability. Survivability requirements can change as a result of emerging technology, evolving threats, and increasing dependence on global information systems.

a. The survivability of Army weapon systems, automated information systems, and other materiel directly impacts system effectiveness and suitability, and consequently, mission accomplishment. The survivability approach must address the system's capabilities to avoid/evade (for example, through non-materiel solutions such as tactics, techniques, and procedures (TTPs)) as well as withstand the effects of expected threats. The survivability evaluation addresses the following areas that are discussed in more detail in paragraph I–5:

— Electromagnetic Environmental Effects (E3).
— Information Assurance (IA).
— Nuclear, Biological, and Chemical (NBC).
— Nuclear Weapon Effects (NWE).
— Electronic Warfare (EW).
— Obscurants and Atmospherics.
— Soldier Survivability (SSv).
— Ballistic Effects.

b. Each survivability evaluation is focused on the susceptibilities of the system and tailored to address the operational requirements of the CBTDEV. The methodology incorporates the CBTDEV's mission critical tasks for the candidate system and addresses operational implications of survivability, including the soldier and TTPs, in the survivability measures.

I–2. Definition and requirements

a. Survivability is defined in the Defense Acquisition Guidebook as "the capability of a system and crew to avoid or withstand a manmade hostile environment without suffering an abortive impairment of its ability to accomplish its designated mission." The Defense Acquisition Guidebook stipulates, "Unless waived by the Milestone Decision Authority (MDA), mission critical systems, regardless of ACAT, will be survivable to the threat levels anticipated in their operating environment. System (to include the crew) survivability from all threats found in the various levels of conflict will be considered and fully assessed as early as possible in the program, usually during System Development and Demonstration." Survivability against the full spectrum of battlefield threats must be considered in all system acquisition programs, including new developments, NDI acquisition, and system modifications/upgrades that can impact the system's ability to withstand the specified threats.

b. Survivability requirements are incorporated in the planning and execution of all aspects of a system's acquisition life cycle. CBTDEVs coordinate the formulation and staffing of survivability requirements during the drafting of the MNS and the ORD. The threat statements and operational environments specified in the MNS guide the preliminary survivability planning. The ORD identifies the survivability thresholds and objectives, defines soldier and system survivability requirements, and identifies the expected threats to the system. The STAR delineates the current and projected threats that should be incorporated into the system's survivability requirements.

I–3. Survivability analyst responsibilities

The survivability analyst has the following unique responsibilities as a member of the system T&E team—

a. Ensure consistency among the STAR, ORD, SEP, and TEMP regarding expected survivability threats and requirements and the tests and analyses that must be conducted to provide input to the evaluation.

b. Define the survivability test and evaluation issues.

c. Coordinate and clarify the survivability evaluation requirements with the combat and materiel developers and the threat community.

d. Develop the IA Survivability Risk Assessment.

e. Develop the survivability input to the TEMP, evaluation plans, and reports.

f. Guide and support survivability analysis, test planning, and data collection as well as related test and evaluation efforts.

g. Conduct and report the survivability evaluation

I–4. Survivability T&E process

The following details the specific steps and procedures necessary to ensure an efficient and effective survivability T&E

process. Most of these steps are unique to the survivability evaluation and should be considered in addition to the basic steps for any evaluation.

a. Review and establish the survivability requirements. System documentation that provides information about the survivability requirements of a system includes the ORD, STAR, and the system description. In addition, the COIC, OMS/MP, and discussions with the CBTDEV are necessary in formulating a survivability evaluation approach that is reasonable, credible, and tailored for the Army's intended use of the system consistent with the critical tasks identified by the user. As appropriate, the analyst should identify AI and measures in developing the survivability portion of the evaluation plan to cover those issues not addressed by the ORD and COIC. HQDA and DOD guidance and policies provide the regulatory basis for formulation of survivability requirements.

b. Gather a complete system description and determine system susceptibilities to the specified threats. System descriptions, configurations, and operational profiles are necessary to determine the significance of the expected battlefield threats. Key system information required as input for survivability evaluation planning includes the following:

(1) Descriptions of the system structure and component parts to determine their primary physical attributes such as electronic, mechanical, digital, radio frequency, optical, electro-optical, and explosive.

(2) Functions of the system and its components.

(3) System deployment/employment (for example, intended interfaces with other systems, protection afforded by enclosures, mounted on a vehicle or dismounted, used in the rear echelon or front line, used in special operations, and used in a stationary or moving mode).

(4) Impact of a component failure on the functioning of the system (for example, Is system survivability lost or degraded? Does the loss of function of some components in the system degrade system survivability? Are such degradations acceptable?).

(5) Threats to the system and its components. Each component in a system will have certain levels of susceptibility to various threats. Components may be susceptible to the same threats or may be uniquely susceptible to a specific threat. Intra-system (as well as inter-system) components can be a threat to each other due to mutual incompatibilities. The overall susceptibility of the system to the threat environment is an aggregate of the susceptibilities of the system components.

(6) Mission impact (that is, So what? How does the degradation affect the system's ability to complete its mission? How does the degradation affect completion of the unit's mission?).

I–5. Survivability evaluation considerations

The following considerations are addressed in the survivability evaluation. The specific models identified in this paragraph are listed as examples only.

a. Electromagnetic environmental effects (E3) evaluation:

(1) Electromagnetic environmental effects refer to the impact of the electromagnetic environment on the operational capability of military forces, equipment, systems, and platforms. E3 threats can come from both hostile and friendly sources and may be either internal or external to the system. Due to the growing complexity of the command and control elements of weapon systems, increased verification of full up system compatibility to E3 environments is required. The Defense Acquisition Guidebook provides guidance for E3 and Spectrum Supportability. Additionally, DOT&E's Policy on Operational Test and Evaluation of Electromagnetic Environmental Effects and Spectrum Management more clearly defines the role of Operational Test and Evaluation in identifying potentially adverse E3 situations. Two MIL–STDs that provide specific system level requirements for E3 are MIL–STD–461E and MIL–STD–464.

(2) The predominant Government E3 test facilities are located at Aberdeen Test Center, MD; Redstone Technical Test Center, AL; Electronic Proving Ground, AZ; and White Sands Missile Range, NM. Test facilities are also located at Patuxent River Naval Air Warfare Center and various Government contractor facilities. Data for the E3 evaluation may also come from sources such as the E3 database maintained by the Joint Spectrum Center, Annapolis, MD, and models such as the Unified E3 (UE3) and General Electromagnetic Model for the Analysis of Complex Systems (GEMACS). GEMACS and its related software enable an electromagnetic analyst to study various EM phenomena associated with antennas, radiation, emissions, coupling, EMI/EMC, and EMP.

(3) E3 encompasses electromagnetic compatibility (EMC); electromagnetic interference (EMI); electromagnetic pulse (EMP); electromagnetic radiation hazards (EMRADHAZ); and the natural phenomena effects of lightning and electrostatic discharge (ESD). This E3 environment is typically created by emitters, electrical motors, and nature (for example, lightning). The following approaches may be employed to resolve E3 problems:

(a) Operational fix—operational avoidance of electromagnetic sources, elimination of particularly susceptible configurations/deployments or elimination of reliance on susceptible items, and mobilization and/or dispersion of assets to increase survivability and compound targeting difficulties.

(b) Proliferation—field the system in sufficient numbers to compensate for expected susceptibilities.

(c) Materiel solution—incorporation of physical or electronic design protection (hardening) by means of shielding, filtering, and protective circuitry. The review and analysis process should consider the merits of the various E3 tests

planned, expected operational electromagnetic environment, applicability of E3 criteria and methodology, and the scope and appropriateness of the E3 measurements and tests. The mission impact of both E3 environment-induced performance and operational degradation should be analyzed. DOT&E guidelines and procedures dealing with E3 and Spectral Management (SM) can be found at http://www.hqda.army.mil/tema.

b. The DOD Policy on Operational Test and Evaluation of Information Assurance, November 1999, defines IA as "information operations that protect and defend information and information systems by ensuring their availability, integrity, authentication, confidentiality, and non-repudiation. This includes providing for restoration of information systems by incorporating protection, detection, and reaction capabilities." Information operations (IO) are actions taken to affect adversary information and information systems while defending one's own information and information systems.

(1) The applicable DOD directives, instructions, and regulations that govern IA are the Defense Acquisition Guidebook, DODD 5200.28, and the Policy on Operational Test and Evaluation of Information Assurance. DOT&E policy guidance applies to DOT&E OT oversight systems and directs the Services to review system IA requirements, plan and develop a test strategy, conduct appropriate developmental and operational assessments, and evaluate IA vulnerabilities during OT.

(2) Widespread use of modern computer technology has led to an increasing dependence on information technology that may be vulnerable to attack. Information technology refers to the hardware, firmware, and software used as part of a system to perform DOD information functions. This increasing dependence on information technology could be a serious problem if hostile agents gain access to sensitive information or deny friendly use. Threat effects include compromise and corruption of data and disruption of operations. Information assurance evaluation needs to be addressed throughout a system's development and testing phases, on preplanned product improvements (P3I), and for spiral development (evolutionary acquisition) to identify the IA shortfalls and to inform the users of the subsequent operational impacts. IA applies to all T&E programs for systems that are dependent on external information sources or provide information to other Army/Joint/Allied Forces systems. The survivability analyst needs to determine whether the information system under evaluation has IA susceptibilities to be concerned about and, if so, identify what can be done to protect it from the threat. For each program, the survivability analyst develops the IA risk assessment. The Army Research Laboratory (ARL) Survivability/Lethality Analysis Directorate's (SLAD) Information Flow model can be used to provide data for the assessment. IA test and evaluation will focus on how well the system under evaluation resists Computer Network Attack (CNA) or Computer Network Exploitation (CNE) methods. The analyst ensures that IA test and evaluation issues are identified in the evaluation plans, TEMP, and test plans.

c. Nuclear, biological, and chemical (NBC) evaluation:

(1) The Defense Acquisition Guidebook requires PMs to address "instantaneous, cumulative, and residual nuclear, biological, and chemical effects" on personnel. Additionally, the Defense Acquisition Guidebook states that "design and testing will ensure that the system and crew can withstand manmade hostile environments without the crew suffering acute chronic illness, disability, or death." AR 70–75, Survivability of Army Personnel and Materiel, specifies that the U.S. Army Nuclear and Chemical Agency (USANCA) is responsible to define all NBC contamination survivability criteria for mission-essential systems and that mission essential systems and equipment will be survivable to NBC contamination. The DA-approved NBC Contamination Survivability Criteria for Army Materiel, 1995, establishes the quantitative criteria for Army materiel designed to perform mission-essential functions. Aspects of an NBC evaluation include: nuclear, biological, chemical contamination survivability (NBCCS), collective protection, detector/alarm integration, decontamination and individual protective equipment storage, and system specific NBC TTPs. The NBC evaluation considers the effectiveness of material solutions and the viability of the TTPs used by the combat developer to mitigate the mission impacts of operations in an NBC contaminated environment.

(2) As defined in AR 70–75, *Nuclear, Biological, Chemical Contamination Survivability* is "the capability of a system (and its crew) to withstand an NBC-contaminated environment and relevant decontamination without losing the ability to accomplish the assigned mission. A Nuclear, Biological, and Chemical contamination survivable system is hardened against NBC contamination and decontaminants, is decontaminable, and is compatible with individual protective equipment." Elements of NBCCS are hardness, decontaminability, and compatibility. Hardness is the ability of a system to withstand the damaging effects of NBC contamination and decontamination. Decontaminability is the ability of a system to be decontaminated to reduce the hazard to personnel operating, maintaining, and resupplying it. Compatibility refers to the ability of a system to be operated, maintained, and resupplied by personnel wearing the full NBC protective ensemble.

(3) Collective protection provides a contamination-free environment (for example, shelters and crew compartments). It is protection provided to a group of individuals that permits reduction of individual mission oriented protective posture (MOPP) levels. Collective protection should be addressed for systems that provide enclosed compartments for NBC survivability of the crew. The evaluation issues include NBC filtration capability, platform integration, and environmental equipment performance in an NBC environment.

(4) NBC agent detector and alarm systems may be incorporated into systems to alert the crew when harmful agents are present. The evaluation should address the integration of contractor-furnished and Government-furnished equipment to determine if any degradation occurs in detector performance. Analysis and testing with simulants can be used to verify the detector/alarm performance.

(5) System load plans should be examined to ensure adequacy of space and location for protective equipment. The survivability and ILS evaluations must ensure adequacy of space and location, and the capability of the crew to gain access to the protective equipment in a timely manner. HFE MANPRINT assessments and test results will establish the level of safe accessibility.

(6) The survivability analyst should consider how TTPs address mission impacts in an NBC environment. Examples of TTPs to be reviewed are decontamination procedures, operational work arounds, and operator/crew training.

(7) The NBC evaluation must consider the CBTDEV's operational mission requirements and the MATDEV's approach for system design, including geometry, materials, and functionality to meeting those requirements. The CBTDEV's operational requirements define the mission profile from which the mission-essential functions and tasks are determined. The evaluation should consider the aspects of NBC evaluation relative to system level integration to include analyses of applicable decontamination procedures, logistics support, and impact to life cycle cost. The survivability evaluation should consider the philosophy on which the DA Approved NBCCS Criteria for Army Materiel are based: "A soldier crew surviving an NBC attack should be able to continue using mission-essential systems and equipment, in a full protective ensemble if necessary. When the mission permits, the systems and equipment should be capable of rapid restoration to a condition such that all operations can be continued in the lowest protective posture consistent with the mission and threat, and without long-term degradation of materiel." The criteria for hardness, decontaminability, and compatibility describe the conditions and data measurements necessary for the system evaluation.

(8) Sources of data for analysis include materials test results and databases (such as test reports and analyses from Dugway Proving Ground, UT and the Chemical Biological Information Analysis Center (CBIAC) database), MOPP IV operational test data, operator/observer feedback, and models such as the ARL's Human Research and Engineering Directorate (HRED) Improved Performance Research Integration Tool (IMPRINT). IMPRINT can be used to characterize the impact of MOPP IV conditions on task completion times. Data requirements for an NBC evaluation are as follows:

(a) Mission profile (to determine exposure time).

(b) Selected quantifiable mission essential functions (materiel) and operation/maintenance tasks (soldier) with associated system components.

(c) Design/material/components/system review and analysis to identify accessible and vulnerable materials and components.

(d) Chemical/biological material databases.

(e) Material susceptibility to agent/decontaminant.

(f) Specific and significant material property change (caused by agent/decontaminant).

(g) Residual agent and desorption rate after contamination and decontamination.

(h) Component/system agent testing (if existing data are not sufficient).

(i) Time to perform tasks in MOPP IV and battle dress uniform.

(j) Problems/comments noted by operators and observers.

(k) System-specific NBC TTPs from the manufacturer and PM, in conjunction with the user requirements.

d. Nuclear weapons effects (NWE) evaluation:

(1) AR 70–75 specifies that USANCA is responsible to define all nuclear survivability criteria for mission-essential systems. This regulation also states that mission-essential electronics must survive high-altitude electromagnetic pulse (HEMP). The MIL–STD–2169B, High Altitude Electromagnetic Pulse Environment, specifies the classified HEMP survivability criteria. A system that must survive at a given distance from a surface or near-surface burst has a requirement to survive HEMP effects as well. System response can be categorized into two main types: 1) the physical/structural response of exposed system components and materials to the ground burst environments of air blast and thermal radiation; and 2) the transient or permanent change response of electronic and electrical components to the electromagnetic pulse and initial nuclear radiation environments. The goal is to provide the appropriate protection for the system. If a necessary fix is very costly or technically infeasible, only the chairman of the Nuclear and Chemical Survivability Committee (the HQDA, DCS, G–3) can grant a waiver (that is, relief from achieving the protection level specified in the criteria, but not relief from the requirement to be nuclear survivable).

(2) Tactical systems will not survive a direct hit from a nuclear weapon surface burst. A surface burst occurs when detonation takes place either on the ground or close enough to the ground that the fireball touches the surface. For example, the diameter of the fireball of a one-megaton weapon may be 1.7 km (1.1 mile). In this case the height of burst must be below .87 km (.54 mile) to cause a surface burst. The reference point on the ground directly below the burst is called ground zero. The criteria are based on the approach that at some distance from ground zero, depending on the weapon size and height of burst, half of the soldiers are expected to survive well enough to be able to complete their mission. The survivability evaluation must assess the system's functionality at these tactical threat levels for the survivors. Air blast, thermal radiation, initial nuclear radiation (INR), and low-altitude electromagnetic pulse are the effects resulting from a surface or near-surface burst and occur within the first minute following detonation.

(3) HEMP results when a nuclear detonation occurs outside the earth's atmosphere. A nuclear detonation produces an electrical disturbance, which is an Electromagnetic Pulse that can cover a whole theater of operations resulting in

theater-wide loss of all susceptible electronic equipment, and with no impact on soldier survivability because humans are not susceptible to HEMP. Since HEMP occurs as a result of detonation of a nuclear warhead above 35 km, no blast, thermal radiation, or INR effects reach the ground. A "HEMP only" requirement typically applies to small systems (for example, the electronically fused round) found in large numbers throughout the theater. The system must be protected against theater-wide loss to HEMP, but localized loss of a small number of systems to blast, thermal, or radiation effects in a surface burst may be acceptable to the user, as specified in the ORD. Consequently, the surface area where unhardened equipment fails could be the size of an entire continent.

(4) Testing and analytical tools:

(a) Test Facilities. HEMP effects on a system cannot be accurately predicted by analysis because current modeling and simulation capabilities cannot adequately characterize the system's response. Thus, HEMP testing is required to provide credible data input to the survivability evaluation. DTC's White Sands Missile Range (WSMR), NM, and the Navy's Patuxent River Naval Air Warfare Center, MD, are facilities capable of conducting system-level HEMP tests. Also located at WSMR are the Large Blast Thermal Simulator (LBTS), Solar Thermal Facility (STF), and several facilities for testing INR effects. The LBTS simulates the blast and thermal effects associated with a nuclear weapon detonation on an integrated nuclear battlefield and is capable of varying shock overpressures and duration independently. The STF provides intense rectangular and shaped thermal pulses for simulation of the high temperature effects of nuclear weapons. For INR testing, the Fast Burst Reactor provides neutron environments; the Linear Electron Accelerator and the Relativistic Electron Beam Accelerator produce INR dose rate environments; and the Gamma Radiation and Eldorado facilities generate INR total dose environments.

(b) Models. For air blast effects the TRUCK model may be useful to characterize vehicle overturn, but it is not useful to predict damage to exterior mounted equipment, thermal radiation, initial nuclear radiation, or HEMP. A model used for thermal radiation effects is the Thermal Analysis of Skins Under Load (TASL). TASL is useful for determining heat distributions across various external surfaces. The model will highlight system thermal radiation vulnerabilities. This information is important for design planning. Some limitations of TASL are that the model does not consider interfaces, layers of material, or blast effects. For INR, the Monte Carlo Adjoint Shielding Code (MASH) model can be used in test and evaluation. It is the only USANCA-approved model for INR analysis of combat vehicle interiors. MASH provides radiation protection factors in the INR environment. The quality of the evaluation depends on a clear understanding of the system's mission, the expected nuclear environments that the system is required to survive, supporting analyses and testing, any modifications to criteria through the waiver process, and the battlefield impact of any open issues.

(5) A significant effort in nuclear survivability test design and evaluation is spent in getting all the proper information. This includes being proactive in interpreting nuclear survivability requirements, defining the scope of testing, and focusing on how the requirements can be met in a cost-effective manner. The level of detail of the evaluation depends largely on the current acquisition phase of the system. Early in the acquisition cycle, the evaluation should address plans for testing and analysis, identify any new technology that could present a risk, and provide an overview of contractor documentation on the internal process of incorporating nuclear survivable parts into the system design. Later in the acquisition cycle, the evaluation will also incorporate test data from the PMO and contractor. Any problems along the way should be clearly documented with the intent of having the problem resolved as early as possible. Mission impacts of any problems, risks, or shortcomings should be evaluated. The analyst and tester should recommend fixes and retesting as deemed necessary based on experience from other systems. The evaluation should address the following: procedural changes implemented, NWE specific instructions in training manuals, implications of any waivers granted, system's ability to complete its mission following exposure to the NWE, and the mission impact of any open issues. The Guide to Nuclear Survivability Evaluation, May 2000, provides guidance to assist in the planning and conduct of nuclear survivability tests and evaluations of Army systems.

e. Electronic warfare (EW) evaluation:

(1) Several sources of requirements, policy, and regulations offer guidance to the analyst when planning the EW evaluation. The STAR is the source of the threat requirements. The Defense Acquisition Guidebook and AR 70–75 provide regulatory guidance.

(2) The various aspects of EW are categorized as Electronic Attack (EA), Electronic Support (ES), and Electronic Protect (EP). The EW considered here pertains to threat EW against U.S. systems.

(a) Electronic Attack (EA) is the area of EW involving the use of electromagnetic or directed energy to attack personnel, facilities, or equipment to degrade, neutralize, or destroy enemy combat capability. EA (for example, electronic countermeasures (ECM), and jamming) can deny or disrupt sensor performance by signal denial or interference, deception, and partial or complete damage. Essentially any equipment having sensors or receivers (for example, communications systems, radar systems, and missile receivers) is susceptible to EA. Effects caused by EA include false alarms, reduced signal-to-noise ratios, false positions (range or velocity), tracking errors, damage to sensor electronics, increased signal-to-noise ratios (to deny information), and damage to human eyes. Some EA devices can permanently destroy electronic components and sensors.

(b) Electronic Support (ES) is the area of EW involving actions to intercept, detect, identify, and locate radiated electromagnetic energy sources for the purpose of immediate threat recognition and attack warning. ES provides information required for decisions involving EW operations, threat avoidance, targeting, and other tactical actions such

as ECM. This information is collected using electronic surveillance measures (ESM), electronic intelligence (ELINT), radar warning receivers (RWR), laser warning receivers (LWR), and acoustic transducers.

(c) Electronic Protection (EP) is the area of EW involving actions taken to protect personnel, facilities, and equipment from any effects of friendly or enemy employment of EW that degrade, neutralize, or destroy friendly combat capability. EP is a response to counter EA or ES threats. EP encompasses ECCM. These techniques include increased transmitter power to “burn through” an interference source, frequency hop signal transmission, large transmit/receive bandwidths, constant false alarm rate algorithms, signal phase coding, polarization diversity, and low sidelobe antenna structure. EP also includes camouflage, concealment and deception (CD) techniques that suppress or modify visual, infrared (ir), and acoustic, seismic, magnetic and radio frequency (RF) signatures. EP signature techniques include use of radar absorbing materials or structure (RAM/RAS), low emissive coatings, indigenous vegetation as covering, terrain for masking (for example, increase of clutter level), decoys, obscurants, and atmospherics. All of these help to suppress or modify target signatures.

(3) ARL’s SLAD is a source of expertise for system EW studies and analyses. Several Army sites exist for EW field and laboratory testing, including WSMR, NM; Fort Monmouth, NJ; and the Electronic Proving Ground (EPG) at Fort Huachuca, AZ. Test sites specifically suited for the signature aspect of EP are ATC, MD; WSMR, NM; Eglin AFB, FL; and NAWC (China Lake), CA. Models and simulators applicable to EW evaluation are the Modular Covert Remote EW Simulator (MCREWS) and the Target Receiver Injection Model (TRIM). Some of the models used specifically for signature evaluations are the Moderate Resolution Transmittance (MODTRAN) model that calculates atmospheric transmittance and radiance, the ACQUIRE model that calculates the probability of threat optic/electro-optic sensors acquiring a target under various environmental conditions, and the VSAT model that calculates probability of detection for top-attack and ground surveillance RF threats.

(4) The focus of the evaluation is whether the system can perform its mission in the operational EW environment specified in the STAR and the ORD. Issues applicable to the EW evaluation include system level RF vulnerabilities, performance degradation, operator workload, survivability equipment employed, operational environment, and any modeling and simulation data requirements.

f. Weapons that employ sensors (and the software logic) may be affected by obscurants, natural aerosols, and atmospheric effects that may be encountered on the battlefield. Sensors are required to perform missions in hot, basic, and cold environments, wet and dry conditions, and urban and open terrain. Sensors need to be effective in combat environments and conditions where target discrimination is difficult. Factors that impact sensor performance include: clutter (natural or battle-induced), optical turbulence from hot roads and terrain, dust from moving vehicles or munitions, burning crude oil, manmade smokes, rain, snow, and fog.

(1) Several methods of testing the effects of the atmosphere and obscurants on weapon systems exist.

(a) One approach is to use the weapon system in the degraded atmospheric or obscured environment and monitor the critical performance criteria of the weapon system (for example, monitor whether the system detected the presented target, received the correct range to target, and successfully tracked the target). While performing these operations, the attenuation to the target and the atmospheric effects can be measured. In general, the technical instrumentation is used to collect data that allows for weapon system modelers to produce accurate models on the effects of the atmosphere and obscurants on system performance.

(b) The use of modeling and simulation is also useful for evaluating the atmospheric and obscurant effects on weapon system performance. The Electro-Optical Systems Atmospheric Effects Library is a library of computer models that examine the effects of atmosphere and weather. This library is managed by ARL–SLAD. The U.S. Army Communications and Electronics Command (CECOM), Night Vision and Electronic Sensors Directorate (NVESD), has models and databases that predict the effects of obscurants and atmospherics on night vision devices. Two of the models, ACQUIRE and FLIR92, assess the impact on thermal imagers. The U.S. Army Missile Command Research, Development, and Engineering Center has models and databases that pertain to the effects of obscurants and atmospherics on missile systems.

(2) In order to determine the effectiveness of weapons systems using sensors, the weapons system should be tested and evaluated for performance in realistic combat environments that include some portion of these atmospheric and obscurant effects. Mission impacts of system operation in these degraded environments should be assessed.

g. AR 602–2, Manpower and Personnel Integration (MANPRINT) in the Materiel Acquisition Process, established Soldier Survivability (SSv) as the seventh domain of MANPRINT. SSv is unique to MANPRINT in that it addresses the survivability of a soldier under combat conditions. SSv is comprised of six components: I—Reduction of Fratricide; II—Reduction of Detectability; III—Prevention of Attack; IV—Minimization of Damage; V—Minimization of Medical Injury; and VI—Reduction of Physical and Mental Fatigue. ARL’s SLAD is designated as the Army lead for performing the SSv assessment on major and designated non-major systems. SLAD is supported by ARL’s Human Research and Engineering Directorate (HRED) and by the U.S. Army Medical Research and Materiel Command. HRED is responsible for the SSv assessment for the remaining non-major acquisition systems. The SSv assessment is used as input to the evaluation in the formulation of issues, measures, and data elements in the survivability test and evaluation plans and reports.

h. System DT and evaluation will generally address system survivability to ballistic threats. Modern threats typically include either man-in-the-loop or autonomous guidance capability. As such, system survivability must consider—

— Acquisition avoidance (don’t be seen).
— Hit avoidance (don’t get hit if seen).
— Kill avoidance (minimize damage to crew or hardware given an impact or perforation by a lethal mechanism).

Acquisition avoidance will generally be captured under E3, EW, or obscurants evaluations. Hit avoidance may be assessed under EW or obscurants if signature suppression, modification, or spoofing are employed. Hit avoidance will be assessed under ballistic survivability if active protection mechanisms are used to physically block or degrade engagement by a threat lethal mechanism. Ballistic survivability must encompass kill avoidance measures (assuming a hit), which will include—

— Protection against lethal mechanism perforation.
— Vulnerability reduction given a threat interaction.
— Design for repair (to enable crew to expeditiously return to battle or remove themselves from the engagement area).

(1) Major systems will be required to undergo congressionally mandated Live Fire Test and Evaluation (see app S). System survivability to ballistic effects is an intrinsic issue for LFT&E, and therefore will be addressed under LFT&E for covered systems. For non-covered systems, ballistic survivability should be addressed in the same building-block approach as identified for major systems in the LFT&E section. Specifically, modeling and testing (as necessary) will be conducted at component level, subsystem/system level, and FUSL, with a goal of identifying damage mechanisms, synergistic damage mechanisms, and crew survivability issues. Crew survivability will always be addressed if applicable. Loss of system functionality will be the primary measure of effects, with the specific criteria (mobility, firepower, and communication) being dependent on the system evaluated. Damage criteria appropriate for the system of interest will be coordinated among the user (TRADOC System Manager), intelligence, and evaluation communities, with ARL/SLAD having responsibility for defining the system criticalities that result in each criterion. The goal of ballistic survivability related T&E is to identify potential areas of ballistic susceptibility as early as possible in the development process, so that possible fixes can be investigated and incorporated as early as possible. Attention must be given to identifying and evaluating those portions of the system that will most affect the system functionality. At all phases of the system development, the evaluation should place emphasis on identifying possible vulnerability reduction features to provide improved survivability for both system and crew. The evaluation of ballistic survivability should include an assessment of survivability to all expected threats identified in the ORD. The STAR should also be reviewed for possible threat classes not specifically identified in the ORD.

(2) Modeling and testing/experimentation play an important role in the determination and improvement of system survivability to ballistic threats and enhancement of munition lethality throughout the acquisition process. ARL/SLAD is the Army’s proponent for system level ballistic vulnerability/lethality models (MUVES/AJEM) that are typically used to conduct trade studies, provide war game inputs, support LFT shot selection, and conduct LFT pre-shot predictions. Other engineering level models can also come into play to address specific damage mechanism or vulnerability reduction issues. Testing and experimentation complement efforts to develop modeling inputs, validate model results and to demonstrate vulnerability reduction design techniques.

I–6. Summary survivability evaluation process

System evaluation is a team process and a survivability analyst will be part of a system team and a T&E WIPT. These teams provide avenues to technical support. In addition to support from team members, support in the areas of survivability is available from other Government agencies, contractors, other survivability analysts, and the analyst’s supervisor. The survivability analyst works in an environment of change. The nature of the design, development, and production processes of systems dictates that documents will require continual updates. Survivability requirements are continuously changed and updated due to the impact of emerging technology, new threats, and increasing dependence on global information systems. The analyst should proactively review the regulations, military standards, test procedures, policies, ORDs, and system descriptions in anticipation of these changes.